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PULPWOOD AND LOG PRODUCTION COSTS AS AFFECTED BY TYPE OF ROAD

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The Occasional Papers of the Southern Forest Experiment Station present information on current southern forestry problems under investigation at the station. In some cases, these contributions were first presented as addresses to a limited group of people, and as "occasional papers" they can reach a much wider audience. In other cases, they are summaries of investigations prepared especially to give a report of the progress made in a particular field of research. In any case, the statements herein contained should be considered subject to correction or modification as further data are obtained.

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Use of motor trucks for the hauling of logs, pulpwood, and other forest products has increased tremendously in the past few years and many timber-using companies now obtain most or all of their requirements by truck transport. It is generally known that this method of transporting raw products from the stump to the mills is a cheap and effective one and will likely be used for a long time. Since this is true, some companies have realized that a system of good roads is quite necessary and have undertaken a large-scale program of road building.

The companies that are building roads, as well as those that are considering such a project, naturally are very much interested in what effect such an expenditure of funds will have on the per-unit production cost for pulpwood, sawlogs, etc. If, in a given instance, road building lowers the cost of production to the extent that the saving on hauling costs is greater than the cost of the road building, it would be poor economy not to do the building. But if the opposite were true, it would be desirable to depend as at present upon nongraded woods and other low-quality roads and the usual long skidding distance during the wet season.

This question of roads is also directly connected with the question of contract rates allowed for hauling forest products. It is customary for the lumber and pulp companies to pay a given unit price for hauling over a given distance or for all hauling within a certain radius of the mill or railroad. This price is usually the same regardless of the type or types of road that must be traversed. Thus, the contractor who has a job where the hauling is all, or practically all, over a good gravel or hard-surfaced road may make a satisfactory to good return on his investment, whereas the second contractor who hauls the same distance but over ungraded woods or rough dirt roads may lose money on his operation.

In order to determine what effect type of road has upon hauling cost, upon total production costs, and upon equitable contract rates, the Southern Forest Experiment Station recently undertook a study of production costs for logs and pulpwood, under dry weather conditions, in the pine-hardwood region of northern Louisiana, southern Arkansas, and eastern Texas. This study, here presented, is supplementary to other studies recently made, but it should be pointed out that because of rapid changes in trucking technique the following information is not the final word on the subject. Considerable variation in logging equipment, type of ground, length of logs, etc., occurs from one locality to another, and the cost figures presented must be adjusted to specific conditions.

Method of Study

As is true in all lines of work, forest products crews are not all equally efficient. Some are above average in the amount of pulpwood or logs they can cut or load or haul per day, some are just average, and because of laziness, physical inferiority, age, or lack of good equipment, some are far below average. Since an efficient company or an efficient contractor is not interested in production costs based on the productive capacity of an inefficient crew, an effort was made to select for this study only those crews and individuals who were average or better than average.

A total of six different sawlog operations and six different pulpwood operations were studied, all of which were run by independent contractors who were producing logs or pulpwood for a pulpmill or sawmill at a definite rate per unit. One each of the pulp and log contractors had only one truck operating. The others had from two to five each. Where possible, two trucks were studied on each job.

Since selective logging is so widely used in this region, all results are based on the removal of products from selectively-cut or selectively-thinned stands. Both pine and hardwood trees were cut into logs, and from 30 to 60 percent of the volume of the stands was removed in each instance. In general, no logs were cut that measured less than 10 inches diameter inside bark at the small end. Pulpwood came from tops of sawlog trees as well as from entire trees. Only pine timber was cut as pulpwood, and the volume removed per acre also averaged from 30 to 60 percent of the stand. For both logs and pulpwood, most of the trees cut were the semi-mature, mature, suppressed, or the defective.

Without exception the pulpwood trucks studied were of the low-priced kind and of 1½-ton capacity, having dual wheels on the rear and capable of hauling two units or two standard cords of wood.

The trucks used on the log-hauling jobs were of the same makes and same rated horsepower as the pulpwood trucks. Several of them had special transmissions giving considerably more power in extreme low gear. All log contractors used steel trailers with two dual wheels and 6- to 7-foot bunks.

Because quite complete data were already available on felling and bucking for both pulpwood and logs and also for the skidding and loading of logs, very little detailed information on these operations was collected at the time of this study. Nevertheless, the total production and total hours worked per day in sawing, skidding, and loading were recorded for all crews employed by each of the contractors selected for study.

In order to check previously acquired data on truck loading and hauling costs and to determine the average time and cost per unit per mile for hauling over three common types of road, the following information was collected on each truck studied:

1. Number of men and teams serving one truck.
2. Work time, including necessary delays, per day for teamster, truck driver, and helpers.
3. Loading time per load.
4. Actual volume of each load, in board feet Doyle-Scribner rule for logs and in units for pulpwood.
5. Loaded travel time for ungraded and unprepared woods roads, for graded dirt roads, and for gravel or hard-surfaced roads traversed on each trip to landing or mill. Also, distances in miles and tenths of a mile for each type traversed on each trip.
6. Unloading time at mill or landing.
7. Return time and distance for each type of road traversed.
8. Number of effective round trips per day.
9. Amount of necessary or unnecessary delay and cause.
10. Approximate cut per acre.
11. Apparent efficiency of crew.

Cost of Log and Pulpwood Cutting

The average production per 8-hour day for all log felling and bucking crews studied amounted to just a fraction over 6,000 feet, Doyle-Scribner rule. Hence, approximately 1.33 crew-hours were required per M feet. The total labor cost plus the amount necessary for supervision, oil, wedges, saw filing, and depreciation amounted to $0.706 per crew-hour (see table 1). Thus, without allowing for profit and risk the cost per M feet (Doyle-Scribner rule) amounted to $0.941.

Table 1.--Estimated hourly cost of a felling and bucking crew of two men

	Dollars	
A. Current operating costs		
1. Direct labor cost		
Labor—2 men	.600	
Social Security—employer 4% (of $0.600)	.024	
Total direct labor cost		.624
2. Other direct cost		
Supplies—oil, wedges, etc.	.026	
Maintenance	.004	
Supervision	.043	
Total other direct cost		.073
B. Ownership cost		
1. Depreciation of saw, axes	.008	
2. Interest, taxes, insurance	.001	
Total ownership cost		.009
Grand total		.706

The average production of pulpwood per crew per 8-hour day was 4.005 standard cords, or approximately 2 crew-hours per standard cord. At $0.706 per crew-hour, the net cost per standard cord amounts to $1.412.

Assuming that the higher cost of 4½- and 5-foot wood is in direct proportion to the larger cubic volume of the unit over the standard cord (the actual difference is somewhat less), the cost of the 4½-foot wood is $1.588 and of the 5-foot wood $1.765 per unit. This is net cost; no allowance has been made for profit and risk. If 10 percent were added to cover this item, the cutting cost would be $1.553 per standard cord, or $1.747 per 144-cubic-foot unit, or $1.942 per 160-cubic-foot unit. An allowance of 15 or 20 percent for profit and risk would increase this cost in proportion.

Cost of Log Skidding and Loading

Practically all log skidding and loading on trucks in the region covered by the study is done with single teams of horses or mules. Except on very long or very short hauls one team and driver is usually allotted each truck, and unless there is a large amount of underbrush the teamster is expected to do his own swamping and preparing of "sets" for loading. In the present instance a swamper was used part time on several of the jobs; therefore it is assumed that one man will be used half time with each loading crew.

The estimated hourly cost (table 2) is $0.617 for the teamster and driver, and the cost of one swamper half time will be $0.156 per hour, a total of $0.773 per hour. With an average output of 700 feet Doyle-Scribner rule per hour the cost of the log skidding and loading (exclusive of the cost of truck and driver) is $1.104 per M feet, Doyle-Scribner rule.

Table 2.—Estimated hourly cost per crew of one team and driver in skidding and loading logs

		Dollars	
A.	Current operating costs		
	1. Direct labor cost		
	Teamster	.300	
	Social Security—employer 4% (of $0.300)	.012	
	Total direct labor cost		.312
	2. Other direct cost		
	Feed	.187	
	Harness and equipment upkeep	.025	
	Supervision	.043	
	Total other direct cost		.255
B.	Ownership cost		
	1. Depreciation of team	.041	
	2. Interest on investment, taxes, etc.	.009	
	Total ownership cost		.050
	Grand total		.617

Time Required for Loading, Unloading, and Delay

In order to determine the truck-hauling fixed costs (which do not vary with length of haul) per cord and per unit of pulpwood for the pulpwood production portion of the study and the fixed costs per M feet (Doyle-Scribner rule) for log production, the total time required to complete the loading in the woods and to unload at the mill or landing, together with the delay time chargeable to each of these operations, was obtained for each load studied. This fixed time for pulpwood loads averaging 1.98 units of 4 x $4\frac{1}{2}$ x 8 feet, and for loads of logs averaging 1,450 feet (Doyle-Scribner rule) per load is given in table 3. The same data would apply equally to loads of pulpwood of 1.98 cords of 4-foot bolts, or of 1.98 units of 5-foot bolts.

Table 3.—Time required per load

Product	Load	Unload	Delay	Total	Basis
	Minutes				No. loads
Pulpwood	44.87	26.61	4.14	75.62	84
Logs	41.30	13.70	9.20	64.20	184

Hauling Time for Various Types of Road

In the relatively flat to gently rolling area in which the present study was made, woods roads are for the most part not roads at all, but merely trails cleared of brush and small trees, over which the trucks can travel from the loading place at or near the point of cutting to the dirt or higher-quality roads. As may be expected, these trails are not straight and are usually quite rough. In dry weather trucks have little difficulty in traveling over such "roads" with a full load, but it is usually necessary to run in first or second gear. In an area where it is necessary, before reaching a road of higher quality, to travel relatively long distances over a woods road, the time required per load may be one-half hour or more. As a result of this, the number of loads possible per day may be two or more per day less than would be possible with a graded, straight, and fairly level road near the place where the cutting is being done. Consequently, the cost for hauling per unit of pulpwood, or per M board feet of logs, over a long distance of woods road may be considerably greater than for hauling the same products over the same distance of graded or high-class road. Therefore, if sufficient volume is to be moved over this woods road, it may pay to build a higher-class road into the area before cutting begins.

In order to present data which a lumber or pulp company or logging contractor could use to determine what roads should be built and where, it was necessary to determine the different costs of hauling; accordingly, records were made of the time required to haul logs and pulpwood over the various types of road. The data obtained are given in table 4.

Table 4.—Time required per load per mile round trip

Product	Type of road		
	Woods	Graded dirt	Gravel or hard surface
	Minutes		
Pulpwood	22.7	7.9	4.7
Logs	21.1	8.6	4.5

Truck Operating Costs

Since the cost of hauling a given quantity of pulpwood or logs varies not only with the volume per load but also with the length of the haul, the truck operating costs have been divided into "fixed expenses" per hour of operation and running expenses per mile of hauling distance. The running expenses have been computed separately for woods roads and for graded dirt and better-quality roads. This distinction is made because the gasoline mileage and tire life for woods roads is considerably less than for graded dirt or gravel roads.

The estimated operating-cost figures for trucks used in pulpwood hauling are given in table 5, and for trucks used in log hauling in table 6. It will be noted that the cost of the driver and the average of 1.63 helpers used on the pulpwood trucks is included in the fixed costs per hour totaling $1.063. Also the cost of the driver for the log trucks is included in the total fixed costs of $0.585 per hour for the log hauling. Because trailers are used in the log hauling but not in the pulpwood hauling, and also because pulpwood trucks get better gasoline mileage, the running cost per mile for log trucks on low-quality roads is $0.121 as compared to $0.087 for pulpwood trucks. For high-quality roads the figures are $0.067 and $0.051. Trucks usually operate 10 hours per day, the owner or employee other than the regular driver taking the last load to the landing or mill.

Summary of Pulpwood Production Costs

In table 7 pulpwood production costs are summarized for standard cords and for units of 144 cubic feet (4 x 4½ x 8 feet) and of 160 cubic feet (4 x 5 x 8 feet). The cost of hauling is necessarily figured on a basis of mileage from the point of loading to the point of unloading. The expense per mile presented in the table includes that of the return trip.

Following is an explanation of the method used to obtain the figures in table 7. The computation of felling and bucking cost has been discussed (page 3). The loading, unloading, and delay (table 3) take 75.62 minutes or 1.260 hours per load of 1.98 standard cords (or the same number of units) at $1.063 per hour, which is equivalent to $0.677 per cord or unit. The hauling time (table 4) per load over woods roads, including the return trip, is 22.7 minutes per mile. Converted to hours this amounts to 0.378 hours, and at $1.063 per hour (table 5) the fixed hauling cost of each load per mile is $0.402. To this must be added the running expenses per mile of $0.087, or $0.174 per mile round trip, making a total of $0.576 per load of 1.98 cords

Table 5.—Estimated costs per truck used for pulpwood hauling

1½-ton 85-hp. truck

	Dollars
Investment	
Truck complete with cab and dual wheels	950.00
Minus tires[1]—6 at $50	-300.00
Net investment	650.00
Minus trade-in value—truck	-200.00
Amount to be depreciated	450.00
Fixed expenses	
Interest on investment[2] at 6%	35.62
License and taxes	51.31
Operating overhead and risk	20.00
Total fixed expenses per year	106.93
Fixed expenses per day (225 days per year)	.475
Depreciation of truck per day—life = 300 days	1.500
Total fixed expenses per day	1.975
Fixed expenses per hour (10-hour day) truck only	.198
Driver and 1.63 helpers, cost per hour	.789
Supervision per unit per hour	.043
Social Security and insurance 4% of labor cost	.033
Total fixed expenses per hour	1.063
Running expenses per mile—Woods or low-quality road	
Tires—life = 8,000 miles	.038
Gasoline—5 miles per gallon	.040
Oil and grease	.003
Repair labor	.003
Repair supplies	.003
Total	.087
Running expenses per mile—Graded dirt or better-quality road	
Tires—life = 15,000 miles	.020
Gasoline—9 miles per gallon	.022
Oil and grease	.003
Repair labor	.003
Repair supplies	.003
Total	.051

1/ Cost of tires charged against running expenses.

2/ Average investment = $\frac{\text{initial investment + trade-in value}}{2}$ + $\frac{\text{annual depreciation}}{2}$ = $\frac{\$650.00 + \$200.00}{2} + \frac{\$337.50}{2} = \$593.75$.

Table 6.—Estimated costs per truck used for log hauling

	Dollars
Investment	
Truck complete with cab and dual wheels	950.00
Trailer complete with dual wheels	450.00
Gross investment	1400.00
Minus tires[1]—10 at $50	-500.00
Net investment	900.00
Minus trade-in value truck and trailer	-300.00
Amount to be depreciated	600.00
Fixed expenses	
Interest on investment[2] at 6%	47.81
License and taxes	51.31
Operating overhead and risk	20.00
Total fixed expenses per year	119.12
Fixed expenses per day (225 days per year)	.529
Depreciation of truck[3] and trailer[4] per day	1.750
Total fixed expenses per day	2.279
Fixed expenses per hour (10-hour day) truck only	.228
Driver, cost per hour	.300
Supervision per unit per hour	.043
Social Security and insurance 4% of labor cost	.014
Total fixed expenses per hour	.585
Running expenses per mile—Woods or low-quality road	
Tires—life = 8,000 miles	.062
Gasoline—4 miles per gallon	.050
Oil and grease	.003
Repair labor	.003
Repair supplies	.003
Total	.121
Running expenses per mile—Graded dirt or better-quality road	
Tires—life = 15,000 miles	.033
Gasoline—8 miles per gallon	.025
Oil and grease	.003
Repair labor	.003
Repair supplies	.003
Total	.067

1/ Cost of tires charged against running expenses.
2/ Average investment = Truck ($593.75—see table 5) + Trailer ($\frac{\$250.00 + \$100.00}{2} + \frac{\$56.25}{2} = \$203.12$) = $796.87.
3/ Life = 300 days.
4/ Life = 600 days.

per mile, or $0.291 per cord. In like manner, the cost of hauling over graded dirt roads was found to be $0.122 per mile of hauling distance, and the cost of hauling over gravel or hard-surfaced roads, $0.093 per mile.

By using the figures in table 7 it is very easy to compute the rate for any given haul. For example, on a haul of 5 miles in which there is 1.0 mile of woods road, 2.0 miles of graded dirt, and 2.0 miles of gravel road the total net cost per cord would be $2.089 (fixed cost) plus $0.291 (for the woods road) plus $0.244 (graded dirt road) plus $0.186 (gravel) or a total of $2.810.

Table 7.—Pulpwood production cost

Cost items	Net cost			Cost plus 10%		
	Per standard cord	Per 144 cu. ft. unit	Per 160 cu. ft. unit	Per standard cord	Per 144 cu. ft. unit	Per 160 cu. ft. unit
	Dollars					
Felling and bucking	1.412	1.588	1.765	1.553	1.747	1.942
Loading, unloading, and delay	.677	.677	.677	.744	.744	.744
Total fixed cost	2.089	2.265	2.442	2.297	2.491	2.686
Hauling per mile:1/						
Woods road	.291	.291	.291	.320	.320	.320
Graded dirt road	.122	.122	.122	.134	.134	.134
Gravel or hard surface	.093	.093	.093	.102	.102	.102

1/ Round trip.

It must be remembered, however, that these figures are for net cost (including interest on investment in equipment) and that no allowance has been made for contractor's profit or risk. If 10 percent is allowed to cover this item in the foregoing example, the total becomes $3.091 per standard cord, and if 20 percent is allowed the total is $3.372 per standard cord.

Sawlog Production Costs

The sawlog production cost is also broken down into a fixed cost for the felling and bucking (page 3), skidding and loading (page 4), and loading, unloading, and delay (table 3), and a variable cost per mile depending upon the type of road (table 4). The two items for loading might be confusing. The first is the cost of the team and driver, who does the loading, and the second is the cost for the truck and driver while the loading is in progress. As has been shown, the cost of the felling and bucking for the logs produced during the study was $0.941 per M feet (Doyle-Scribner rule). The skidding and loading cost, including the employment of a swamper half time, was $1.104 per M feet; and the cost of the truck and driver while loading and unloading was $0.626 (1.07 hours at $0.585 per hour) per average load of 1,450 feet, or $0.432 per M feet (Doyle-Scribner rule).

The total fixed net cost, therefore, amounts to $2.477 per M feet (table 8) and applies regardless of the length of haul. For larger timber, however, these fixed costs would probably be lower, since large logs generally require less time per M feet than small ones to fell, buck, skid, and load. Conversely, for smaller timber fixed costs would probably be higher.

Table 8.—Cost per M feet[1/] for sawlog production

Cost items	Net cost	Cost plus 10%
	Dollars	
Felling and bucking	.941	1.035
Skidding and loading	1.104	1.214
Loading, unloading and delay	.432	.475
Total fixed cost	2.477	2.724

1/ Doyle-Scribner rule.

Log hauling cost, like pulpwood hauling cost, varies depending upon the length of haul and the type of roads traversed. Furthermore, it will change also according to the volume per load. Since the size of the average log—and therefore of the average load—will vary considerably from one relatively small area to another, it is desirable to base the rates for hauling over the different types of road encountered upon size of the average log carried. This has been done in table 9. The volume of the average load carried when handling logs of different average sizes is also given in the table.

Table 9.—Cost per M feet[1/] of hauling logs 1 mile[2/] over three types of roads by average load

Average log	Average load	Type of road		
		Woods	Graded dirt	Gravel or hard surface
Board feet		Dollars		
60	1,060	.423	.205	.168
70	1,110	.404	.196	.160
80	1,160	.386	.188	.153
90	1,215	.369	.179	.146
100	1,265	.354	.172	.141
110	1,320	.339	.165	.135
120	1,370	.327	.159	.130
130	1,420	.315	.153	.125
140	1,470	.305	.148	.121
150	1,520	.295	.143	.117

1/ Doyle-Scribner rule.
2/ Round trip.

The method of computing the cost of hauling over the different types of roads (table 9) is the same as was used for computing the pulpwood costs. For example: It required 21.1 minutes (table 4) to traverse one mile round trip when traveling over woods roads, and this is equivalent to 0.352 hours. With the total fixed expenses per hour at $0.585 (table 6), the fixed cost for the hauling is $0.206 per load. In addition, the cost for running

expenses when traveling over woods roads is $0.242 per mile round trip ($0.121 per mile one way). Thus, the total cost per mile for running plus fixed expenses while running is $0.448. For average loads of 1,450 feet the cost per M feet per mile is $0.448 divided by 1.450 or $0.309. The costs for loads of other average volumes were computed in a similar manner.

The same method has been used to compute the cost per round-trip mile when hauling over graded dirt and over gravel or hard-surfaced roads. Thus, on a given haul over 1 mile of woods road, 2 miles of graded dirt road, and 2 miles of gravel road with the logs averaging 140 feet each the total cost would be $2.477 plus $0.305 plus $0.296 plus $0.242, equaling $3.320 per M feet, Doyle-Scribner rule. As was mentioned in the discussion of pulpwood costs, these figures are net costs (including interest on investment) and do not allow anything for profit and risk. If this is figured at 10 percent, the cost of the haul in the example becomes $3.652. If the allowance is 20 percent above net cost, the total becomes $3.984 per M feet.

Application of Results to Other Conditions

It is realized that cutting and hauling conditions, timber size, and trucks and equipment undoubtedly will vary from one locality to another. The information as given, therefore, cannot and should not be applied in any given area in the South without checking with actual conditions as found in the locality. The data obtained in this study have been presented in such form that these adjustments can easily be made. For instance, if truck or labor cost is greater or less than that given, the estimated hourly (or hourly and per mile) rates can be adjusted accordingly, and the new rates applied to the time figures presented in the report. If the volume per load of logs should be greater or less than that given, the only adjustment that need be made is to divide the cost per round trip by the new volumes to obtain the adjusted cost per M feet.

However, it can be readily seen that in practically all cases these adaptations are not half so important as the adjustment of contract rates for different types of roads. With the rates constant regardless of types of roads over which the hauling is done, one contractor may "go broke" hauling 5 miles on all-woods road, whereas a second trucker may make good money hauling the same distance on good gravel or hard-surfaced road.

If the volume to be hauled over a given route is roughly known, these data can also be used as a basis for determining whether construction of a graded dirt road is justified in places where only woods roads are available, or whether it will pay to improve a graded dirt road by graveling.